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First Semester M.Tech. Degree Examination, June-July 2009
Advanced Digital Communication

Time: 3 hrs.   Max. Marks:100

Note: *Answer any FIVE full questions.*

1 a. What are the goals in digital communication design? **(03 Marks)**
   b. Compare analog and digital transmission for communication over long distance with necessary diagrams. **(05 Marks)**
   c. Draw a neat block diagram of a digital communication system capable of handling analog and digital information sources and sinks and explain in detail the various operations carried out by each block. **(10 Marks)**
   d. A scanner has a resolution of 600×600 pixels/sq inch. How many bits are produced by an 8-inch × 10-inch image if scanning uses 8-bits/pixel and 24-bits/pixel? **(02 Marks)**

2 a. Assume the spectrum of a channel is between 3MHz and 4MHz and the SNR_{dB}= 24 dB. Find the following and also state the associated formula used:
      i)   Find the channel capacity (in the presence of noise.)
      ii) The number of signaling levels needed to achieve the channel capacity (in the absence of noise). **(06 Marks)**
   b. What is line coding? Encode the stream 101011100 using unipolar, NRZ-L, NRZ-I, Bipolar, Manchester and differential Manchester line coding schemes. **(04 Marks)**
   c. Compute the codeword to be transmitted for the information sequence 1010 using $X^5 + X^4 + X + 1$ as the generator polynomial and also draw the shift register circuit for implementing the CRC. **(07 Marks)**
   d. A high-quality speech signal has a bandwidth of 8 kHz. Suppose the speech signal is to be quantized and then transmitted over a 28.8 kbps modem. What is the SNR of the received speech signal? **(03 Marks)**

3 a. Describe Entropy and Discrete memoryless channel. **(04 Marks)**
   b. A source generates messages using six different symbols with probabilities of 1/2, 1/4, 1/8, 1/16, 1/32 and 1/32. Find the entropy of the source and compare it with a source of six equally-likely symbols. **(06 Marks)**
   c. State the properties of mutual information. **(04 Marks)**
   d. Draw the transitional probability diagram of a binary symmetric channel. Calculate the probabilities of binary symbols 0 and 1 appearing at the channel output when the input binary symbols 0 and 1 occur with equal probability. Repeat the calculations assuming that the input binary symbols 0 and 1 occur with probabilities of 0.25 and 0.75 respectively. **(06 Marks)**

4 a. Draw a block diagram depicting the basic elements of a PCM system and describe the eight basic signal processing operations that are performed on the message signal. **(10 Marks)**
   b. Given the signal $x(t) = 10 \cos(8000\pi t) \cdot \cos(2000\pi t)$. What is the minimum sampling rate based on the low pass sampling theorem and the bandpass sampling theorem. **(05 Marks)**
   c. A binary channel with a bit rate of 36000 bps is available for voice communication. Signal is band limited to 3.2 kHz. Find the appropriate values of the following :
      i) Bits per sample ii) Number of quantization levels iii) Sampling rate. **(05 Marks)**

5 a. Explain the concept of Delta modulation. (02 Marks)

b. Describe the operation of Delta modulation system with diagrams of transmitter and receiver. (08 Marks)

c. Explain the following :
   i) Slope overload distortion and evolve a condition to avoid the same.
   ii) Granular noise distortion. (04 Marks)

d. A Delta modulator is designed to operate 5 times the Nyquist rate for a signal with 3 kHz bandwidth. Determine the maximum amplitude of a 2 kHz input signal for which the delta modulator does not overload. Quantization step size is 250 mV. Derive the formula used. (06 Marks)

6 a. Draw a block diagram of a baseband binary data transmission system and evolve an equation for the output produced for the ith transmitted bit and with its help explain Intersymbol Interference (ISI). (08 Marks)

b. State the Nyquist's criterion, expressed in terms of frequency domain, for the distortionless baseband transmission and explain the ideal solution with the pulse shape and amplitude response diagrams for zero ISI and the practical difficulties in the implementation of the same. (08 Marks)

c. A binary pass wave is to be transmitted over a low pass channel with an absolute maximum bandwidth of 75 kHz. The bit duration is 10 micro seconds. Find the raised cosine spectrum that satisfies these requirements. (04 Marks)

7 a. With suitable schematic diagram explain the operation of duo binary signaling scheme with and without precoding. (10 Marks)

b. The binary data 011100101 are applied to the input of a modified duo binary system.
   i) Construct the modified duo binary coder output and corresponding receiver output, without a precoder.
   ii) Suppose that due to error during transmission, the level at the receiver input produced by the third digit is reduced to zero. Construct the new receiver output.
   iii) Repeat the above two cases with a use of precoder. (10 Marks)

8 Write short notes on the following :
a. Eye diagram
b. Digital modulation
c. Digital Hierarchy
d. Adaptive sub-band coding. (20 Marks)

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